C-AD

Radiation

Safety

Committee

Issued: March 21, 2007 DB

Minutes of Radiation Safety Committee of March 20, 2007

Subject: EBIS port with protons injected into Booster via LtB

Present: D. Beavis, L. Ahrens, J. Alessi, D. Raparia, K. Yip and P. Bergh

The subcommittee reviewed issues related to the EBIS penetration and the request to inject protons from the LINAC using LtB.

Fault Study Results

Two fault studies were conducted with 200 MeV protons in the LtB transport line to the Booster. 10^{11} protons per second were used in both fault studies. The first fault study used a valve downstream of the EBIS-LtB beam crossing as a target. The valve is 0.25 inches thick. In the second fault study the beam was swept around using the large dipole of LtB to see if a thicker target or a more sensitive area could be hit. In both studies there was no detectable radiation outside of the EBIS penetration. An upper limit of 0.2 mrem/hr was obtained for this intensity.

Model Predictions

K. Yip has performed several calculations of the expected dose outside of the penetration using MCNPX[1]. The largest potential dose rate was obtained if the protons can strike the beam pipe tee directly. A dose of $1.8*10^{-16}$ rem/p was obtained with some restrictions around the EBIS beam pipe. A dose of $3*10^{-17}$ rem/p was obtained if 3.4 inches of stainless steel flanges were stuck downstream of the beam crossing. The 3.4 inches assume that the four flanges were struck when in reality only one extends to the smaller beam pipe diameter. The valve used in the first fault study is 0.25 inches thick and is located between the flanges discussed above. Therefore, one can expect a dose per proton approximately a factor of 10 lower or about $3*10^{-18}$ rem/p.

The beam striking the valve or one layer of flange should have produced radiation at the port exit of 1-3 mrem/hr. This is approximately a factor of 10 times higher than the upper limit established by the fault study. For now the committee will use the fault study number but keep the difference in consideration for later concerns. P. Bergh was requested to provide information on any response issues for the HPI-1010, which was the instrument used in the measurements.

Beam Optics

D. Raparia has examined the beam optics for the LtB transport line[2]. It is not possible to strike the beam cross-over tee with the use of the bending magnets including the small steerer magnet. Deflecting the beam with the dipoles causes the beam to scrap in a long pattern upstream of the cross-over. In addition, the downstream outer flanges cannot be hit. However, at lower energy the small steering magnet may be able to deflect the beam sufficiently. Insufficient details were presented on the steerer magnet to understand what was achievable at lower energies.

Conclusions

The planned operation for the immediate future is to inject the Booster with 200 MeV protons with intensity of about 10^{12} protons per second. This intensity is achieved by not pulsing one of the solenoids in the beam transport from the high intensity source, which causes a large beam reduction. The low intensity pulses will be interleaved with high intensity pulses to BLIP. This type of operation has been done in the past but the EBIS penetration did not exist until this year.

A fault of the LtB beam transport could cause the beam to scrap near the EBIS port. Using the fault study results this would create less than 2 mrem/hr outside the EBIS port.

Both a beam transport fault and a BLIP proton beam of 10^{14} protons per second would create less than 200 mrem/hr at the EBIS penetration exit in the linac building.

The maximum beam intensity for injection at the Booster ASE is $7.5*10^{14}$ protons per second.

There may be fault modes which have not been explored by the fault studies conducted. This may include changes in beam energy. The maximum possible extrapolated radiation levels are expected to be up to a factor of 100 higher than the fault studies, representing the worst case calculations. However, at present these fault modes do not appear to be achievable.

Radiation levels outside the shield wall are estimated to be 50-100 times lower than at the penetration exit.

The committee recommends that protons be allowed to be injected with the following changes:

1) Move the interlocking chipmunk to the penetration opening.
2) The monitor chipmunk can be removed.

3) Determine that the small steering dipole cannot cause beam losses at the cross-over point for beam energies above 100 MeV.
4) Keep the present shield wall in place.
5) Keep the barrier in place to prevent access to the penetration.
6) Place an administrative restriction on the beam energy to be greater than 100 MeV.
7) The buffer zone outside the shield wall can be removed.

Additional review and potential studies will need to be performed to determine the final configuration.

Attachments (file copy only)

1) K. Yip, e-mail to D. Beavis, May 1, 2006
2) D. Raparia, “Fault Studies for the LtB-EtB Region”, March 15, 2007.

CC:

Present
RSC
RSC Minutes file
RSC EBIS File
RSC Booster File